Mercury Levels in High-End Consumers of Fish

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Consumption of food containing mercury has been identified as a health risk. The U.S. Environmental Protection Agency (U.S. EPA) and the National Academy of Sciences recommend keeping the whole blood mercury level < 5.0 µg/L or the hair level < 1.0 µg/g. This corresponds to a reference dose (RfD) of 0.1 µg/kg body weight per day. All patients in a 1-year period (n = 720) who came for an office visit in a private internal medicine practice in San Francisco, California, were evaluated for mercury excess using the current RfD. One hundred twenty-three patients were tested (93 females, 30 males). Of these, data were statistically analyzed for 89 subjects. Mercury levels ranged from 2.0 to 89.5 µg/L for the 89 subjects. The mean for 66 women was 15 µg/L [standard deviation (SD) = 15], and for 23 men was 13 µg/L (SD = 5); 89% had levels exceeding the RfD. Subjects consumed 30 different forms or types of fish. Swordfish had the highest correlation with mercury level. Sixty-seven patients with serial blood levels over time after stopping fish showed a decline in mercury levels; reduction was significant (p < 0.0001). A substantial fraction of patients had diets high in fish consumption; of these, a high proportion had blood mercury levels exceeding the maximum level recommended by the U.S. EPA and National Academy of Sciences. The mean level for women in this survey was 10 times that of mercury levels found in a recent population survey by the U.S. Centers for Disease Control and Prevention. Some children were > 40 times the national mean. *Key words:* accumulation, amalgam, children, fish, methyl mercury, pregnancy. *Environ Health Perspect* 111:604–608 (2003). doi:10.1289/ehp.5837 available via *http://dx.doi.org/* [Online 1 November 2002]

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Fish accumulate methyl mercury in their tissues, where it becomes strongly bound. Methyl mercury is not removed from fish tissue by any practical cooking method (Chicourel et al. 2001; Morgan et al. 1997; U.S. EPA 1999).

Methyl mercury is absorbed on average 95% when consumed. From the bloodstream, it is taken up by all tissues, with an initial phase of distribution of 1–2 days after a single dose (Clarkson 1997). It is excreted predominantly in the feces but also in urine and sweat. A conversion factor of 1:250 has been used to convert hair to whole blood (4.0 µg/L × L/1,000 g × 250 = 1.0 µg/g; Clarkson 1997; Mahaffey and Rice 1998).

Methyl mercury can accumulate if consumed at a greater rate than it is excreted. It has a strong affinity for sulfhydryl groups in tissues and accumulates to a greater concentration in brain, muscle, and kidney (NAS 2000).

Methyl mercury crosses the maternal to fetal blood compartments, where it binds to red blood cells and other fetal tissues. By the time of parturition, cord blood is on average twice that of the maternal blood concentration. Individual studies have reported mother to cord blood ratios much greater than 1:2 (Bjerregaard and Hansen 2000; Hansen et al. 1990; Vahter et al. 2000; Weiss 1994).

Methyl mercury easily crosses the blood–brain barrier, where biotransformation to inorganic mercury takes place. The brain:blood concentration ratio when the initial distribution phase is completed is between 10:1 and 5:1. Once in the central nervous system, methyl mercury can be demethylated to inorganic mercury. This latter form of mercury has a long half-life in brain tissue and can be measured in years (Clarkson 1997; Davis et al. 1994; Pedersen et al. 1999). The average half-life in blood for methyl mercury in adults is 70 days, in children 90 days, and in lactating women 46 days (Swartout and Rice 2000).

In this article we report the dietary habits and corresponding mercury levels of patients in a San Francisco, California, internal medicine practice who consume excess mercury through fish, many of whom had mercury levels at or greater than the U.S. EPA's RfD.

Methods

All patients in a general internal medicine practice in San Francisco who came for an office visit during a 1-year period were evaluated for risk of mercury excess. The practice is mostly middle to higher income patients. Patients were asked to estimate from a list of fish the average number of times per week or month they ate each fish, and the length of time they were on their current diet. The patients were given an opportunity to add other fish to the list. The average restaurant serving of fish in five local restaurants that subjects frequented was reported to be 5.0–8.0 ounces (150–227 g). Patients were asked to estimate the portion size that they consumed per serving. A reference amount of 170 g or 6-oz can of tuna was used to help patients estimate their intake. Some patients gave a range for their frequency of intake.

The ranges were averaged based on a 28-day month. Portion size was converted to a size of 5.0–8.0-oz (150–227 g) portions per month. Canned tuna was measured in 6-oz (170 g) cans per month. To separate tuna from lobster or crab, sushi and shellfish were placed into separate categories. To estimate risk of mercury exposure, portion size in grams for each type of fish meal eaten by patients was multiplied by the average mercury content of that fish, as determined by published tables [Food and Drug Administration (FDA) 1995; Mahaffey and Rice 1998]. Table 1 shows mercury data used for the 11 most commonly eaten fish for this study population.

Those whose dietary history suggested their mercury intake was at or greater than the RfD for their average monthly intake, 0.1 µg/kg body weight per day, were asked to be screened with a whole blood mercury test. Patients were also tested if they had symptoms consistent with methyl mercury excess regardless of estimated dietary levels of mercury. These symptoms, such as fatigue, headache, decreased memory, decreased concentration, and muscle or joint pain, have been delineated in large epidemiologic studies as symptoms of mercury excess (Fukuda et al. 1999; Harada 1995). The criteria for symptoms were that the patients had sought health care for symptoms or that symptoms affected daily living. Patients were excluded if fish were obtained

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